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THE PHYLOGENY OF THE ACORN BARNACLES

BY RUDOLF RUEDEMANN

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Communicated by J. M. Clarke, October 29, 1918

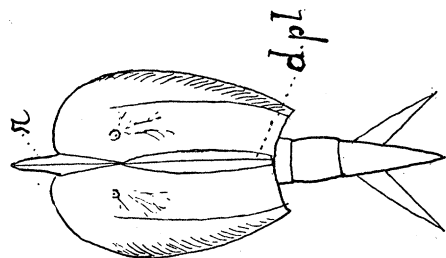
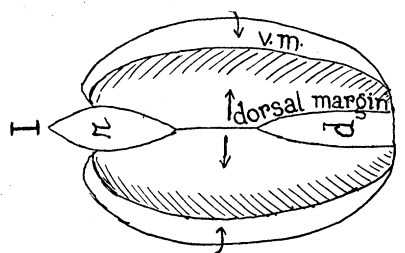
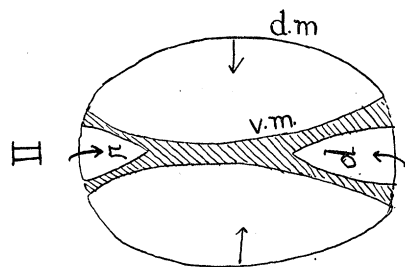
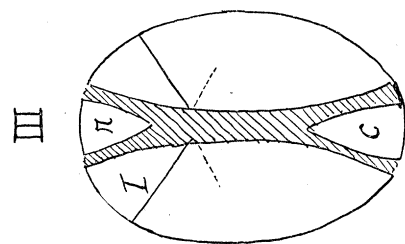
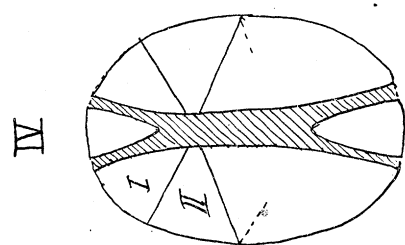
The Acorn Barnacles of Balanidae represent the most advanced stage of regression attained in the Cirripedes through adaptation to a sessile life. Darwin regarded them as derived from the Lepadidae or Goose Barnacles by the loss of the peduncle, and this view has been generally accepted. The whole order of Cirripedia is interpreted by some students as derived from the Copepoda, but others find its ancestors in the ostracodes, because of the bivalved 'Cypris-stage' through which the larva passes after the Nauplius-stage and directly before attachment. Balfour, however, in his treatise on *Comparative Embryology*, 1880, p. 424, emphasizes the presence of paired, compound eyes as well as the large bivalve shell, and has urged their "independent derivation from some early bivalve Phyllopod form."

It has further been recognized that a reduction in the number of the compartments (wall plates) or lateralia has taken place, probably by coalescence. The typical *Balanus* has four lateralia, two on each side; besides these the rostrum and carina, or six compartments in all. But the most generalized living genus *Catophragmus* has eight compartments, or three lateralia on each side. Paleontologists know in the Devonian fauna *Protobalanus hamiltonensis* Whitfield, an acorn barnacle with 12 compartments or 5 lateralia on each side.

Investigations of the Utica and Lorraine faunas of the Upper Ordovician have recently brought to light a new form of acorn barnacle, which like *Protobalanus*, has five lateralia on each side, but differs in the form of these lateralia in such a way as to shed a most important light on the problem of the origin of the barnacles. In *Protobalanus* the five lateralia, which are all acutely triangular plates, point uniformly upward or inward towards the mouth. In the new form, which will be described as a species of the new genus *Eobalanus*, these plates are arranged as shown in the diagram, the four outer lateralia as in *Protobalanus*, while the middle one is inverted, forming a sort of keystone in the series. The second and fourth are furthermore somewhat truncated at the apex.

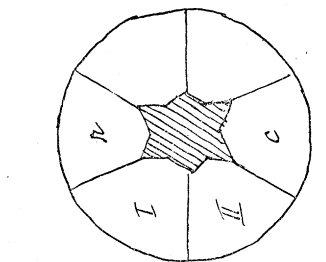
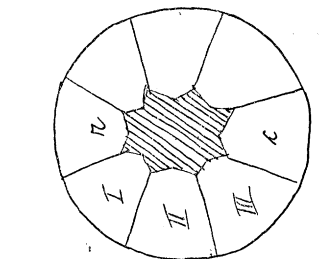
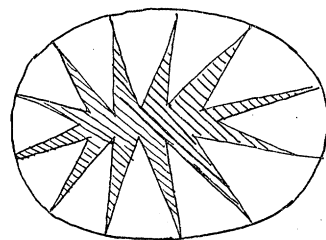
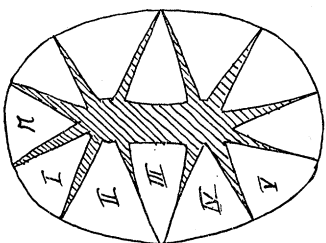
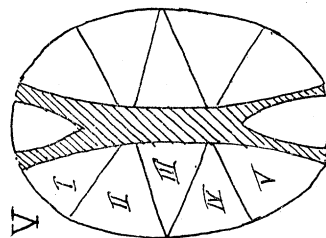
The effect of this peculiar shape of the lateralia is that, if they could be matched together like the parts of a picture puzzle, they would give a perfect, snugly-fitting carapace, as shown in diagram V. This carapace is bivalved as in phyllopods, with the rostrum and carina of the barnacle corresponding to the rostral plate of the crustacean in front and the 'dorsal plate' behind, exactly as in the Devonian genera *Mesothyris* and *Rhinocaris*.

We have then to picture the derivation of an *Eobalanus* as from a *Rhinocaris*-like phyllopod as illustrated in the set of diagrams. The first diagram



I-V. DEVELOPMENTAL STAGES.

RHINOCARIS



EOBALANUS

PROTOBALANUS

CATOPHRAGMUS

BALANUS

shows the carapace of the crustacean just before attachment with the head portion and the dorsal side downward—a rather natural position for phyllopods, which, like *Apus*, are wont to swim on their backs, while foraging along the bottom.

The head and back being thus protected by attachment, but the ventral side open to attack, the next step will be the separation of the carapace valves along the hinge line and their movement upward towards the ventral side; and likewise the rostral and dorsal plates will have to move upward to fit in again between the valves (stage II of diagrams). Following this was the breaking up of the valves into the lateralia, owing to stresses exerted at one or other end, possibly the anterior one where the originally chitinous and somewhat flexible valve was attached. Here also, our material affords a clue to the mode of procedure. A very early growth stage of *Eobalanus* shows four radially arranged, subequal, oval plates, the two lateral ones of which show a suture along which a smaller part is being split off. It is thus to be inferred that the compartments were formed by successive splitting off of plates from the original valve, each fissure producing a new pair of lateralia. In this way the peculiar interlocking arrangement of the compartments in *Eobalanus* would finally have come about and each valve of the carapace have been divided up without leaving a useless remainder.

The scuta and terga which form the valvular carapace or operculum of the upper aperture of the later *Balanidae* and *Lepadidae* and which are of great taxonomic importance, have not been found in *Eobalanus* and *Protobalanus*, and in our view did not exist then, but are a later development to close in more completely the ventral side. They are not fundamental structures.

POSSIBLE DERIVATION OF THE LEPADID BARNACLES FROM THE PHYLLOPODS

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STATE MUSEUM, ALBANY, N. Y.

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Mr. Ruedemann's discovery of an elemental balanid and his constructive deduction therefrom of the origin of the acorn barnacles, sets this form of symbiotic degeneration back to an historic stage, where its phylogeny is indicated in its own structure. The degeneration is already complete and hence implies a long time for the acquirement of such adaptation, but it is also so simple as to indicate its procedure. If *Eobalanus* intimates the rise of the *Balanidae* through the decline and dependence of the *Phyllopods*, it is opportune to regard the evidence bearing on the phylogeny of the other great division of the barnacles, the *Lepadidae* or Goose Barnacles.